Extrapolation to infinite nuclear matter

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The phase diagrams recently obtained for the ISiS and EOS data sets were for finite systems [1, 2]. Those results are now extrapolated to infinite nuclear matter.

Finite size effects are paramount in nuclei; e.g. the binding energy per nucleon decreases from the $\sim$ 15.5 AMeV for nuclear matter to $\sim$ 8 AMeV for nuclei. This lowering of the binding energy is understood to be due to the surface (and Coulomb) energy.

Such a reduction will also affect the critical temperature T_c. Thus, from first principles, for a finite system it can be written

$$\frac{T_c^{A_0}}{T_c^{\infty}} = \frac{a_V A_0 + a_S A_0^{2/3}}{a_V A_0} = 1 - \frac{1}{A_0^{1/3}} \qquad (1)$$

where A_0 is the mass number of a given nucleus. In the ISiS and EOS reactions, remnants of different sizes (and thus different $T_c^{A_0}$ values) are characterized giving a wide range of A_0 values. The full ISiS and EOS data sets were fit to Fisher's droplet model as before [1, 2], but using Eq. (1) to give $T_c^{A_0}$ with T_c^{∞} as a fit parameter.

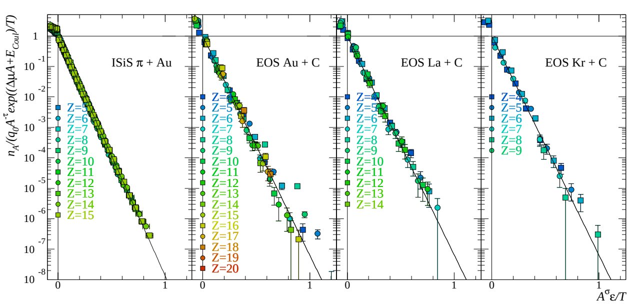

Figure 1: Fisher scaling and finite size scaling analysis of the ISiS and EOS data sets.

The preliminary results are shown in Fig. 1. The fit parameters are almost the same as in the previous analyses [1, 2]. The extracted values for the critical temperature of infinite nuclear matter are $T_c^{\infty} \sim 13.6$ MeV from the ISiS data and $T_c^{\infty} \sim 12.9$ MeV from the EOS data. These values agree with theoretical estimates of the critical temperature of bulk nuclear matter.

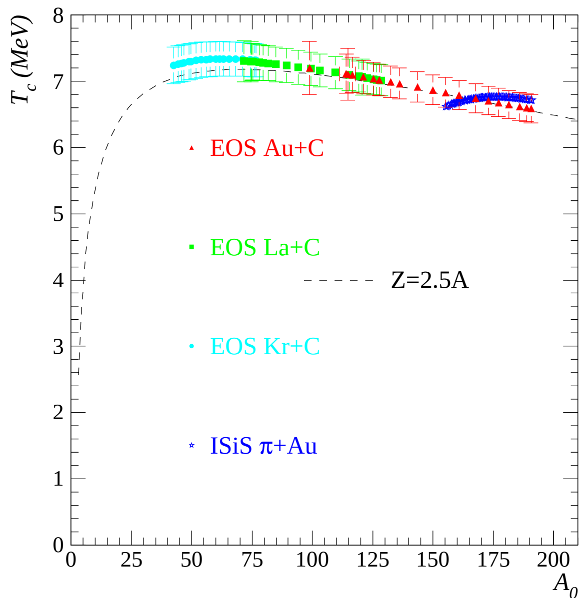

Figure 2: Variation of the critical temperature with nucleon number for the ISiS and EOS fragmenting remnants.

The distribution of $T_c^{A_0}$ is shown in Fig. 2 resembles the nuclear binding energy curve because for a nucleus Eq. (1) becomes

$$\frac{T_c^{A_0}}{T_c^{\infty}} = \frac{B(A_0, Z_0)}{B(\infty, 0)}, \qquad (2)$$

the ratio of the binding energy of a given nucleus of mass A_0 and charge Z_0 to the bulk binding energy.

References

[1] J. B. Elliott *et al.*, Phys. Rev. Lett. **88**, 042701 (2002).

[2] J. B. Elliott *et al.*, to be submitted to Phys. Rev. C (2002).